interference, in a manner similar to Kœnig's well-known apparatus for that purpose, constructed on the method of Wheatstone.

JOHN G. MCKENDRICK

THE GEOLOGICAL SURVEY OF NEWFOUNDLAND

DUE notice of the Report for 1874, of Mr. Murray, the Director of the Newfoundland Geological Survey, has been delayed until the appearance of the map and sections referred to in that Report. These we have now received, and as they deserve more than ordinary attention from geologists, we propose to give some account of the recent work of the Survey. The able and indefatigable Director, who, like his late chief, Sir William Logan, has grown grey in the service of the Dominion, divides his Report into two parts, one of which narrates his own labours during 1874, while the other is furnished by his assistant, Mr. J. P. Howley, of whose surveys for the same period it gives the main results. Mr. Murray's Report is marked by that quiet practical good sense which formed so characteristic a feature of his contributions to the Canadian Geological Survey. It is more occupied with plans and advice for opening up the country to settlers, and developing the great resources of the island in timber and as a cattle-grazing district, than with geological matters. The latter are treated, too, with an eye to future mineral industries. Mr. Murray, in short, is doing the solid and useful work of pioneering. That work may make no brilliant display at the time, but if, as he hopefully anticipates, there is a prosperous future before Newfoundland, the colonists will look back upon his labours as those which largely guided and stimulated that prosperity.

But Mr. Murray is too true a geologist to let any chance escape him of advancing the purely scientific treatment of geology. And he is fortunate in possessing in Mr. Howley a geologist who can carry out his views with admirable skill. From Mr. Howley's Report and Map geologists in other countries will learn some particulars not only important as regards the geology of the colony, but of general interest as bearing on the question of the nature and *modus operandi* of the metamorphic action to which the origin of such rocks as dolomite and serpentine is attributed.

Mr. Howley's labours during 1874 were, in accordance with Mr. Murray's plans, given to the survey, topographical and geological, of the western coast of Newfoundland, about the peninsula and bays of Port-a-Port, and St. George's Bay. In tracing the Lower Silurian formations of the Newfoundland coast, Mr. Murray and his colleagues have been able to identify them with more or less precision as equivalents of the Quebec and Birdseye and Black River groups of Canada. But in the course of their surveys they have at different times encountered intercalated sheets of metamorphic rocks in the Lower Silurian series overlying unaltered and fossiliferous strata. Thus at Bonne Bay, in 1862, Mr. Richardson found highly metamorphosed rocks, including white talcose slates and serpentine, in some portion apparently of the Quebec group. Four years afterwards Mr. Murray observed further south, in the Bay of Islands, that sandstones believed to represent the Sillery zone of the Quebec group passed below the serpentine of the Blowmedown mountains. Mr. Howley has now confirmed and extended these observations by mapping the country between the Bay of Islands and St. George's Bay. He has traced Mr. Murray's serpentine rocks southwards to Bluff Head, and finds that they pass unconformably over different horizons of rocks which are taken to represent the Sillery and Levis subdivisions of the Quebec group of the Lower Silurian system. The striking character of this unconformable junction is well brought out upon the map, where two large cakes of the overlying rocks are seen to sweep over both anticlinal and synclinal folds of the lower formations. These cakes consist of brecciated dolomite or limestone, chlorite-slate, diorite, and serpentine, having a total thickness of perhaps 1,500 feet. Their exact geological horizon seems not yet quite satisfactorily fixed, but they are placed provisionally between the Sillery and Birdseye and Black River formations. Doubtless further details will be given in future reports regarding this remarkable feature of Newfoundland geology, and till they appear it may be well to avoid any discussion of the theoretical aspect of the subject. It is not the first time that an instance has occurred of the higher rocks of a district being more metamorphosed than the lower, but there has probably never been observed so remarkable a case, for here the metamorphosed and contorted series is described as actually overlying unmetamorphosed strata.

Other questions of interest occur in the Report. Thus a centre of pre-carboniferous volcanic action is indicated as existing along a line north of Fox Island and on the coast to the south head of the Bay of Islands. The coal-measures, of which a few patches occur in the district surveyed, overlap from the Millstone Grit on to the Carboniferous Limestone. The latter formation contains, according to Mr. Davidson, brachiopoda which all belong to well-known British species. In another respect there is a curious analogy between the base of the Carboniferous system in Newfoundland and in some parts of Britain. In the former country the lower members of that system consist largely of red and green sandstones, clays, and conglomerates, with traces of plants, beds of gypsum, and occasional limestones full of ordinary Carboniferous Limestone fossils. Anyone who has looked at the base of the Carboniferous system in Cumberland, Westmoreland, Dumfriesshire, and other parts of Britain, will recognise these lithological features as characteristic also in this country. It would seem that the same physical conditions preceded the deposition of the Carboniferous Limestone on both sides of the Atlantic—inland seas or lakes, not far separated from the sea, in which red sediment with gypsum and occasionally common salt was laid down, but which were not usually well suited for the support of molluscan life, though liable now and then to inroads of the sea outside and to invasions of mollusca, corals, and other marine forms.

The map, on a scale of four miles to an inch, is evidently a piece of most careful work. It shows the arrangement of the rocks from the Laurentian group up to the Coal-measures, though, partly from vast unconformabilities and partly from faults, great portions of the geological series are not represented in this part of Newfoundland. It may be mentioned, in passing, that the largest fault traced on the map—that which flanks the Laurentian range from Table Mountain north-eastwards to Grand Pond—is not coincident with the line of any river, but is crossed by all the chief rivers and brooks in the district which it traverses. Hence the same relation between fracture and erosion exists there which has been so extensively traced and keenly discussed in this country. To the completion of this important map geologists will look forward with not less interest than must be taken by those who see in the labours of Mr. Murray and his associates one of the best pledges for the early development of the colony.

A. G.

THE ANCIENT BRITISH PIG

PROF. ROLLESTON has recently been making some researches on swine, the discovery of some remains buried in the alluvium, near Oxford, having directed his attention to the subject. In illustration of a paper "On the Prehistoric British *Sus*," read by him at the Linnean Society, June 15, the following specimens were exhibited :—1. Skull of *Sus scrofa*, var. *domesticus*, from a late Celtic interment. 2. Skulls of *Sus scrofa*, var. *ferus*, from

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alluvium near Oxford, and from Germany. 3. Skull of *Sus andamanensis,* forwarded him by J. Wood Mason. 4. Skull of *Sus cristatus,* lent by Sir Walter Elliott, K.C.S.T. 5. Skull of *Sus barbatus* wrongly named *S. verrucosus,* and needlessly *Euhys barbatus* in some mammalogical catalogues.

From these and other data the author bases the subjoined conclusions:—

1. The domesticated pig of Pre-Roman times, as exemplified at least by the specimens from the interment referred to, appear to resemble *Sus scrofa,* var. *ferus,* rather than *S. cristatus,* or the domestic variety, *S. indicus.*

2. On the other hand, *S. cristatus,* the Indian wild hog, appears to him, whilst being readily and always distinguishable from *S. scrofa,* var. *ferus,* to differ from it, mainly by the retention permanently of certain structural conformations which were only temporarily represented in the European wild species. The third molars of the male, *S. cristatus,* varied, however, concomitantly with its canines, and showed a much larger development of their posterior lobe, than either *S. scrofa,* var. *ferus,* or the females of their own species. The rearmost lobe, however, of the posterior molar, varies a good deal in *S. scrofa,* var. *ferus,* irrespective of sex.

3. Bearing in mind the elasticity of the swine type and the power for changing which their domestication has shown to possess, Dr. Rolleston has less difficulty in conceiving that the so-called *S. indicus* was really a modified *S. cristatus,* than that it had been evolved from any *Sus,* such as *S. leucomystax,* from countries farther away from Europe than India. *S. cristatus* had the malar border of the lachrymal always marked by the relative shortness insisted on by Nathusius. It had not the relatively wider palate; but upon this point too much weight had been laid.

4. A skull of a wild sow, from the alluvium, later in date than the "river gravels," near Oxford, combined the short lachrymal characteristic of young pigs and of *S. cristatus,* with the worn down teeth, elongated facial skeleton, and disproportionally small size of an old wild sow, *S. scrofa,* var. *ferus.* Such a combination of characteristics tended to suggest carefulness as to accepting the Torf-Schwein *S. scrofa,* var. *palustris,* of Rütimeyer, as a distinct species, or taking even such a point as the shortness of the lachrymal as constituting a specific difference.

5. The simplicity of the third molars in the very large skull of *S. barbatus* appear to be of greater value, as the rugose condition might have been expected to be forthcoming in so large, so well armed, and so well fed a *Sus* as this from Borneo.

6. The true *S. verrucosus* differs from *S. barbatus* in having the lachrymal's malar edges long, relatively to its orbital, as well as in the peculiarities which its specific name implies. These peculiarities were reproduced in the old Irish "Greyhound Pig" figured by Richardson "Domestic Pigs," p. 49, Ed. Warne.

7. The often-quoted paper by Dr. Gordon, *Medical Times and Gazette,* May 2, 1857, p. 429, led us to suppose that *Taenia solium* of man, infested the domestic pig of India, as it does those of other parts of the world. The facility with which the pig lends itself to domestication enables us to understand how the many-sided commensalism which now exists between man and that animal may have set up in very early times. Indeed the particular results of their commensalism which their solidarity, as regards the alterations of the generations of *Taenia solium* represents, suggests that their co-existence in time must have been more extensive than even the co-existence in space ascribed to them, not quite correctly, by Gibbon ("Decline and Fall," chap. ix. note 9, p. 392, Smith's edition).

PHOTOGRAPHIC PROCESSES[1]

II.

WE next pass on to other applications of the dichromates for the production of prints, and the first I shall demonstrate is that known as carbon printing, but which is perhaps more correctly termed the autotype process. It is dependent on the oxidation of gelatine, one of the substances which you may have already guessed would be capable of being acted upon by the dichromates. If, then, we have a film of this gelatine impregnated with potassium dichromate, and after drying it be exposed to light, it will be found that all the portions acted upon will become insoluble in hot water; that is, supposing the duration of the exposure be of sufficient duration, and if the light be sufficiently intense. Imagine now that beneath a negative of delicate gradations of light and shade we place a film of sensitive gelatine, supported for convenience' sake on paper, and allow sunlight to act upon it. After a time, in what condition will the gelatine be? It will be partially insoluble, more particularly on the surface next the negative, and the lights and shades will be represented by different depths of insoluble matter, according to the intensity of light penetrating through the various parts of the negative. I must here pause, and try and explain why this is. At first sight it might seem that the *whole of the thickness of the film* ought to possess different ratios of solubility. This is not true, however; the solubility is affected to different depths. That coloured component of white light which is principally effective in producing the chemical change is blue, and which consequently finds a difficulty in piercing through the orange-coloured dichromate. The amplitude or height of the blue wave is continually diminished, till finally it is almost extinguished. Now the intenser the white light the greater will be the original amplitude of this wave, and it is at once apparent that the limit of amplitude, which is effective to cause the chemical change, will be reached at a greater depth by those rays of light which were originally the brightest. A little reflection, then, will show you that the soluble part of the gelatine will principally be next the paper, and on immersion in hot water the viscous unaltered gelatine would remain imbedded between it and the outer insoluble surface. Though several ingenious methods have been tried to render the support on which the gelatine rested sufficiently porous to allow the occluded parts to be washed away, yet, so far, no attempt has been completely successful. To get over the difficulty the principle has been adopted of transferring the gelatine film to a temporary support, the outside surface being caused to adhere to it. Evidently, by this means, the soluble gelatine can be washed away when the paper is peeled off, and a raised image insoluble in water would remain, which eventually may be transferred to its final support. The temporary supports, usually employed are metal plates, glass, paper coated with an insoluble compound, &c. A picture in gelatine alone, however, would be, comparatively speaking, of little value, as it is almost colourless; but if pigments be mixed with it the objection disappears. In the autotype process the gelatine is mixed with colouring matter and a coating is given to a piece of paper. When dried the gelatine can be rendered sensitive by floating its surface on a solution of potassium dichromate, and after again drying is ready for printing. Such a piece of prepared paper, or carbon tissue as it is technically called, we have here. It has already been exposed beneath a negative, but no trace of any image is apparent, as the dark colour of the pigment masks it entirely. In order to judge of the amount of light received during exposure resort then is had to what are called actinometers. The detail of the instruments I will not enter into; suffice it to say it is usual to judge the depth of printing by the colour given to silver chloride. Placing then the exposed tissue, gelatine side downwards, beneath water in which a zinc plate has already been immersed, and bringing the surfaces of the two together, they are withdrawn from the water with a film of moisture between. You will notice that I left the print in the dish but a very short time, for a reason which you will presently understand. By passing this "squeegee" (which is a bar of wood from which a thick strip of india-rubber projects) over the back of the paper I drive out all the water from between the surfaces, and you see how the gelatine film clings to the zinc. And why is this? You will find that it is not naturally adhesive, the light has changed the quality of the gelatine in this respect, then why does it hold so tight to the metal plate? Simply owing to the moisture left in the paper; the soluble gelatine soaks it up and expands. It cannot well expand laterally, so it expands upwards, and a partial vacuum is created between the gelatine and the plate. Now you see why I left the print in the water such a short time. Had I left it in longer the total expansion would have taken place, and the necessary vacuum could not have been created when it was pressed on to the zinc plate.

Now that it is firmly held, I can place it in hot water and remove the paper. It easily peels off, and the solvent action of the fluid can have fair play. As I move it up and down in the trough, you can see the gelatine running over the surface. After a few minutes it is clean, and the development is finished. On this plate I have another print which has already undergone similar treatment, but has been allowed to dry. This piece of

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[1] Lecture by Capt. Abney, R.E., F.R.S., at the Loan Collection, South Kensington. Continued from p. 241.

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